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NAVAL POSTGRADUATE SCHOOL
Monterey, California

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DESCRIPTIVE MODELS OF
MONTHLY OFFICER ATTRITION

Robert R. Read

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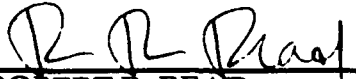
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Descriptive Models of Monthly Officer Attrition

Robert R. Read

Abstract

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Introduction

This report supports the Officer Rate Generator (ORG) used in the Marine Corps manpower personnel flow models, [1,2]. The goal is to build a general purpose system that will convert officer personnel data into attrition (i.e. departure from the Corps) probabilities that are valid for time intervals of several lengths, and sensitive to other important classifying parameters. Grade, years commissioned service, occupation specialty are major classifiers but others, such as commissioning source, gender, etc. can be required as well. These requirements have the effect of inducing a large number of cells which have low personnel inventory and the building of a rate generator under these circumstances poses the major problem. Modern multi-parameter estimation schemes have been applied and tested in recent work [3,4,5].

1

Previous research has supplied a validated method for the one year lead time window. This method has been implemented into the ORG software. The present work deals with the refinement of attrition rates for shorter time periods, specifically one month. Monthly attrition is necessarily much smaller than yearly attrition, and the statistical modelling is much more difficult. Some descriptive models are developed using logistic regression techniques. Some ad hoc suggestions are made for adjusting the monthly rates so that they become compatible with annual rates in an appropriate sense in order to create a usable consistent system.

The data are separated by grade and the main MOS categories that are used in the ORG system. The most important effects uncovered are zone and months. Three promotion zones: in & below, once passed over, and twice passed over have very pronounced effects upon attrition behavior. The twelve months themselves are also important, but not as sharply. Occasionally some two factor interactions between these two are significant.

The years in the study, 1982-1992, are also quite important, but of course they have no predictive value. Instead, it was found that the unemployment rate (lagged by three months) emerged as a useful covariate. Unimportant effects include gender and the dates of convening of the promotion boards.

The report is organized as follows. Section 1 contains the notation, terminology, and the choices made in the modelling process. Section 2 contains comments concerning the statistical methods used and a number of other caveats. The results are contained in Section 3. Some exploratory computations are presented in Section 4 in which the consistency issue is considered and the forecasting ability for periods which are multiples of a single month. The summary remarks appear in Section 5. Some appendices are included which document some of the more tedious details.

1. Terminology and Notation.

The data were extracted from the ORG software and contain monthly personnel inventories and losses broken out by grade, ycs (years commissioned service), promotion zone, MOS category, and gender for the eleven fiscal years 1982 through 1992.

Grade. Five grades were used.

Lt	-	lieutenant
Capt	-	captain
Maj	-	major
Ltcol	-	lieutenant colonel
Col	-	colonel

Zone. Three promotion zones were used.

i&b	-	in and below zone
1pass	-	once passed over
2pass	-	twice passed over

MOS Category. The study used regular officers in each of the following eight groups:

cbt	-	ground combat
cs	-	ground combat support
css	-	combat service support
fwp	-	fixed wing aviators
rwp	-	rotary wing aviators
ags	-	air ground support
nfo	-	non flying officers
law	-	lawyers

Months. The fiscal year begins in October and the twelve months have been summarized into four levels, as follows.

L	-	November
M	-	Dec, Jan, Feb, Mar, Apr, Aug, Sep, Oct
H	-	May, July
VH	-	June

3

There are 132 consecutive months used in the study. It is useful to tabulate the average monthly losses and personnel inventory by grade, MOS group, and zone. These are contained in Table 1. Attention is drawn to several features of this table.

There are no colonels in MOS groups other than cbt and law.

The average personnel inventory levels vary by grade and MOS group, and are dominated by the i&b zone. The inventory numbers for 1pass and 2pass are small.

The loss numbers are quite small for all zones; so small that it is unwise to apply standard asymptotic goodness of fit testing for model acceptance. The tabled numbers are averages over 132 months and many of the individual cells have zero counts.

The rates (loss/inv) increase sharply with zone.

y = cell loss counts n = cell personnel inventory

$$\text{odds} = y/(n-y) \tag{1}$$

Logistic regression models:

$$\ln(\text{odds}) = \text{const} + \beta x + \lambda_i^M + \lambda_j^Z + \text{error} \tag{2}$$

where x = unemployment percentage lagged by three months

β = unemp3 regression coefficient

λ_i^M = seasonal effect i = L,M,VH with $\lambda_H^M \equiv 0$

λ_j^Z = zone effect j = 1pass, 2pass with $\lambda_{i\&b}^Z \equiv 0$

In four cases, specifically captains in MOS groups cbt, cs, css, and rwp

$$\log(\text{odds}) = \text{const} + \beta x + \lambda_i^M + \lambda_j^Z + \lambda_{ij}^{M:Z} + \text{error} \tag{3}$$

with the addition constraints
all $\lambda_{Hj}^{M:Z} \equiv 0$ and all $\lambda_{i,i\&b}^{M:Z} \equiv 0$

Remark: The average value $x = \bar{x} = 7.076515$ is used in the tabulated attrition rates, Table 3.

TABLE 1

Averages: Losses and Personnel Inventory

	Lt		Capt		Maj		Ltcol		Col	
cbt	loss	inv	loss	inv	loss	inv	loss	inv	loss	inv
i&b	1.33	461.84	2.62	759.55	0.42	441.47	1.11	299.64	1.02	242.32
1pass	0.15	8.11	0.30	26.28	0.06	46.16	0.44	24.58	0.87	49.21
2pass	0.37	2.84	1.42	13.39	1.34	60.26	1.23	34.39	2.93	70.67
cs										
i&b	2.04	630.55	3.21	926.52	0.51	446.88	0.90	242.31		
1pass	0.36	13.98	0.23	33.69	0.11	41.29	0.39	18.68		
2pass	0.66	5.29	2.17	17.65	1.65	71.28	1.01	25.14		
css										
i&b	2.25	537.60	4.58	986.60	0.64	450.79	1.01	195.64		
1pass	0.29	13.19	0.30	34.49	0.19	38.23	0.40	14.55		
2pass	0.44	4.35	1.85	18.57	0.39	62.41	0.79	19.75		
fwp										
i&b	0.05	64.86	3.63	438.88	0.54	258.29	1.28	214.18		
1pass	0.01	0.83	0.20	8.05	0.10	38.90	0.62	14.40		
2pass	0.05	0.28	0.33	2.51	1.36	63.71	0.72	15.63		
rwp										
i&b	0.08	138.23	3.01	686.26	0.37	377.38	0.94	199.89		
1pass	0.00	1.82	0.23	17.80	0.05	39.20	0.24	14.36		
2pass	0.05	0.80	0.89	8.98	1.28	62.14	0.67	15.38		
ags										
i&b	0.63	159.96	0.89	242.58	0.20	102.40	0.21	46.93		
1pass	0.08	3.75	0.08	6.55	0.05	7.99	0.07	3.08		
2pass	0.17	1.11	0.30	3.19	0.31	11.75	0.19	4.16		
nfo										
i&b	0.20	74.87	0.67	194.48	0.20	139.54	0.67	194.48		
1pass	0.00	0.21	0.04	6.59	0.05	17.02	0.04	6.59		
2pass	0.00	0.13	0.34	2.96	0.59	27.11	0.34	2.96		
law										
i&b	0.03	9.38	0.66	142.24	0.39	86.77	0.24	51.10	0.04	15.69
1pass	0.00	0.09	0.05	3.00	0.01	8.53	0.02	3.34	0.05	2.96
2pass	0.00	0.02	0.11	1.13	0.24	12.14	0.17	4.80	0.14	3.57

2. Statistical Issues.

The data were organized and treated by means of logistic regression using the S-PLUS statistical software system. Exploratory work was performed using a number of models and with varying degrees of success. It was decided to choose a single modelling system and stay with it for the present purposes.

More specifically, the use of twelve months leads to confusion concerning the importance of individual months; indeed such importance was variable from set to set. The L,M,H,VH coding was introduced to simplify the interpretations. It also saves eight degrees of freedom. These codes successfully represent low, moderate, high, and very high attrition provided the officer grade is major or greater. However these same codes are used for the lieutenants and captains and they do provide significant discriminators, but the attrition rates do not necessarily increase monotonically with the codes as they do for the higher grades.

There are several cases for which M has a higher estimated level than H. There are instances in which the VH level is smaller than the others. Generally the standard errors of estimation are sufficiently large that these discrepancies can be identified as single levels. Such alterations were not executed, however.

The use of the unemployment rate, lagged by three months, generally is the best use of this covariate, but not in every case. In some cases it is not a particularly important variable. The distinctions are small however, and it seemed wise to stay with a single policy.

Generally, the cell inventory counts are adequate for the i&b level of the zone factor, and are generally much smaller for the other two levels of this factor. The loss counts are much too small to support the use of standard asymptotic goodness if fit test procedures. But the methods for the relative comparison of competing models are believed to be suitable.

There are 132 cells; monthly counts for each of eleven years. It was decided to include zone as a three-level factor rather than to fit models separately for each zone. This allows the i&b level to influence the overall model fitting and, hopefully, to provide greater stability.

The use of ycs (years commissioned service) as a factor has the effect of fragmenting the personnel inventory numbers to even smaller levels and it was not used. It could be viewed as a refinement of zone. Some exploratory work was done with this factor; it does not appear to be particularly important. On the other hand, a noticeable exception was uncovered; twice passed over majors with 20 ycs.

As the usual asymptotic chi squared test for model adequacy is inappropriate, we instead applied an ad hoc technique. The results appear in Table 2. There are four statistics for each cell: Deviance; Ratio of deviance to null deviance; Degrees of Freedom; Ratio of deviance to degrees of freedom. Let us explain the role of each.

Generally, deviance is the difference of the negative log likelihood evaluated at the maximum likelihood estimates of the model parameters and that of the saturated model. Null deviance is the deviance when the fitted logistic regression model is a constant. The deviance listed is that associated with the model that we have selected. This is a linear first order model using zone and coded months as factors and the lagged unemployment rate as a covariate in most cases. (In four cases the two factor interactions between zone and month were used as well, specifically captains in the MOS groups cbt, cs, css, rwp.)

Let us interpret Table 2. The ratio of deviance to null deviance is necessarily in the interval (0,1). The tabled values vary from 0.37 to 0.83 and we assert that the reductions are significant. In spite of the small cells one must remember that the estimates are still maximum likelihood estimates and the comparison of deviances should be meaningful. The proposed models are better than the constant model.

TABLE 2
Fitting Summaries

		Lt	Capt	Maj	Ltcol	Col
cbt	dev	347.78	592.96	407.60	500.96	647.35
	dev/null	0.52	0.37	0.39	0.54	0.41
	df	328	383	389	383	375
	dev/df	1.06	1.55	1.05	1.31	1.73
cs	dev	493.17	702.56	375.42	484.07	—
	dev/null	0.46	0.32	0.33	0.55	
	df	382	377	389	383	
	dev/df	1.29	1.86	0.97	1.26	
css	dev	498.40	670.70	404.14	478.82	—
	dev/null	0.57	0.37	0.83	0.60	
	df	361	383	389	383.	
	dev/df	1.38	1.75	1.04	1.25	
fwp	dev	63.47	387.42	386.95	462.35	—
	dev/null	0.54	0.62	0.45	0.58	
	df	228	340	389	383	
	dev/df	0.28	1.14	0.99	1.21	
rwp	dev	* 82.72	546.99	368.93	409.31	—
	dev/null	0.66	0.47	0.39	0.63	
	df	320	375	389	383	
	dev/df	0.26	1.46	0.95	1.07	
ags	dev	241.35	312.90	227.91	409.31	—
	dev/null	0.58	0.63	0.64	0.63	
	df	299	347	389	383	
	dev/df	0.81	0.90	0.59	1.07	
nfo	dev	111.06	295.30	271.59	295.30	—
	dev/null	0.79	0.57	0.55	0.57	
	df	167	352	389	352	
	dev/df	0.67	0.84	0.70	0.84	
law	dev	* 27.28	244.27	236.13	204.22	127.57
	dev/null	0.93	0.78	0.74	0.78	0.70
	df	135	286	383	348	371
	dev/df	0.20	0.85	0.62	0.59	0.34

* The estimation algorithm did not converge after 10 iterations. These entries are based upon the estimates available from the iterations, but such estimates are not used elsewhere in the report. Instead these two cells are marked as "NO FIT" in the other performancee summary tables.

Two of the cells are marked with asterisks. The maximum likelihood equations did not converge. The corresponding Table 2 values were included for inspection. The numbers look similar to the other numbers in the table, suggesting that the estimates were near convergence. But the point was not pursued and these two cases are marked as "NO FIT". We used the empirical averages over the months in the rate summary (Table 3) for these two cases.

The total number of cells is 396 in each case. The basic first order model has seven parameters and the one that included two factor interactions has thirteen. The maximum number of residual degrees of freedom is 389 and 383 respectively. This is achieved only for seven cases for the majors and in two cases for the captains. In all remaining cases there are empty cells and the S-PLUS system removes them from the count. The lowest degree of freedom figure is 228 for Lt in the group fwp.

The fourth component of the entries in Table 2, deviance divided by degrees of freedom, allows a comparison of the model fit with expected value. Under chi squared large sample theory the expectation of the deviance is the degrees of freedom and it is comforting when this ratio is not too large. In one instance the deviance is 86% higher than its degrees of freedom. Other high value cases produce 55%, 73%, 75%, and 46%. Also these cases are generally associated with the larger cells. We are not necessarily satisfied with these cases. We are more comfortable with many of the remaining cases, however. Some simulation work has suggested that these ratios are to be expected in small cell – low probability situations [6]. In some cases the ratios are smaller than one. These could merit further study.

The standard analysis of variance summaries for the model fitting appears in Appendix A. We have the following remarks for the thirty-two ANOVA tables (4 grades by 8 MOS groups plus 2 for colonels reduced by two for the "no-fits").

i. The unemployment covariate is not significant in 12 of the 32 summaries.

ii. The two factor interactions were used for captains in the groups cbt, cs, css, rwp. The summaries for these cases support that decision.

iii. The seasonal factor (months) seems unimportant for majors in css, lieutenants and captains in fwp, captains and lt-colonels in nfo, captains and lt-colonels in ags, and captains in law.

3. Results.

Gender. A brief preliminary study was performed in order to judge the value of using gender as a factor in the models. Since there are so few females in the Corps it was necessary to aggregate the data considerably in order to conduct the study. We used the eleven year averages in the ground and aviation groups broken out by zone, grade and gender. There were no females in aviation during this time period. The raw data appear in Appendix C. The additive model using gender, zone, grade and group produces a huge deviance to degrees of freedom ratio. Acceptable fits emerge if we extend the previous to include the two factor interactions of zone and grade. Then the ratio is 1.42 with 28 degrees of freedom. The ANOVA summary is given below for this latter model. The test of gender having no effect passes rather easily. Of course there could be an effect using more refined partitions of the data, but continued effort in this direction did not suit our purposes.

Gender was excluded in all of the follow on modelling. The inventory and loss counts were pooled over the two genders.

ANOVA table for Gender

	Df	Sum Sq	M Sq	F	p
Gender	1	0.00	0.00	0.00	0.997
Group	1	1.65	1.65	0.79	0.382
Zone	2	711.37	355.69	170.30	0.000
Grade	4	114.51	28.63	13.71	0.000
Zone:grade	8	38.71	4.84	2.32	0.048
Residuals	28	58.48	2.09		

Other Variates. The recency of dates (see Appendix D) of the convening of the promotion boards was tested for its role as a covariate. It exhibited no descriptive power. It might have been better to use the dates of effectiveness of the boards' decisions, but this information was not available. Moreover, for purposes of prediction, information of this type can only be available during a rather curtailed set of time windows, and hence would be of rather limited value.

Modelled Rates. The parameter estimates, their standard errors, and "t" statistics are tabulated in Appendix B. This information enhances that contained in the ANOVA summaries. Generally it can be said that the attrition rates for 1pass are a bit higher than those for i&b; the rates for 2pass are substantially higher. When two factor interactions are used, most are not very important. But the 2pass by season interaction is nearly always noticeable.

Fitted attrition rates are presented in Table 3. In these computations we use the average unemployment rate, lagged by three months, for the 132 months in the study, i.e. average = 7.076515. If one wants an attrition rate when the lagged unemployment rate is x, then one must multiply the tabled rate by the exponential function of beta times the deviation of x from the average. The appropriate value of the regression coefficient beta can be found in the tables of Appendix B, marked "unemp3".

TABLE 3
Modelled Monthly Attrition Rates

		Lt			Capt			Maj			Ltcol			Col		
cbt	L	0.001	0.007	0.055	0.003	0.041	0.301	0.000	0.001	0.011	0.002	0.010	0.020	0.001	0.006	0.013
	M	0.003	0.018	0.127	0.003	0.007	0.103	0.001	0.001	0.015	0.003	0.015	0.030	0.003	0.013	0.029
	H	0.004	0.025	0.170	0.004	0.009	0.042	0.001	0.002	0.025	0.004	0.020	0.039	0.005	0.022	0.050
	VH	0.003	0.022	0.155	0.005	0.020	0.049	0.003	0.005	0.074	0.008	0.040	0.076	0.016	0.065	0.141
cs	L	0.002	0.017	0.083	0.002	0.022	0.312	0.000	0.001	0.010	0.002	0.011	0.020			
	M	0.003	0.022	0.108	0.003	0.005	0.115	0.001	0.002	0.016	0.003	0.018	0.034			
	H	0.005	0.037	0.169	0.004	0.004	0.047	0.001	0.003	0.023	0.004	0.023	0.043			
	VH	0.004	0.035	0.162	0.004	0.009	0.070	0.005	0.012	0.092	0.008	0.046	0.083			
css	L	0.002	0.012	0.056	0.004	0.024	0.330	0.001	0.003	0.003	0.002	0.013	0.018			
	M	0.003	0.017	0.078	0.004	0.006	0.080	0.001	0.005	0.006	0.004	0.022	0.031			
	H	0.007	0.037	0.160	0.005	0.004	0.041	0.001	0.005	0.006	0.007	0.035	0.049			
	VH	0.007	0.034	0.148	0.006	0.026	0.097	0.002	0.007	0.009	0.013	0.069	0.094			
fwp	L	0.000	0.000	0.000	0.008	0.024	0.127	0.001	0.001	0.010	0.003	0.020	0.021			
	M	0.001	0.011	0.192	0.008	0.024	0.129	0.001	0.002	0.016	0.006	0.041	0.043			
	H	0.001	0.007	0.135	0.006	0.019	0.107	0.002	0.003	0.021	0.007	0.048	0.050			
	VH	0.001	0.011	0.192	0.006	0.018	0.099	0.007	0.011	0.074	0.007	0.050	0.053			
rwp	L	0.001*	0.000*	0.057*	0.003	0.016	0.329	0.001	0.001	0.011	0.003	0.009	0.023			
	M	0.001*	0.000*	0.057*	0.004	0.012	0.080	0.001	0.001	0.014	0.004	0.015	0.038			
	H	0.001*	0.000*	0.057*	0.005	0.012	0.024	0.001	0.001	0.021	0.006	0.020	0.051			
	VH	0.001*	0.000*	0.057*	0.003	0.017	0.076	0.004	0.005	0.074	0.008	0.030	0.074			
ags	L	0.005	0.029	0.181	0.004	0.015	0.111	0.000	0.001	0.005	0.002	0.010	0.020			
	M	0.002	0.014	0.091	0.003	0.012	0.088	0.002	0.005	0.022	0.004	0.021	0.040			
	H	0.009	0.052	0.285	0.003	0.012	0.088	0.002	0.006	0.027	0.005	0.028	0.053			
	VH	0.003	0.019	0.122	0.004	0.014	0.106	0.006	0.018	0.080	0.008	0.039	0.075			
nfo	L	0.000	0.000	0.000	0.006	0.010	0.177	0.001	0.001	0.009	0.006	0.010	0.177			
	M	0.002	0.000	0.000	0.003	0.006	0.108	0.001	0.002	0.016	0.003	0.006	0.108			
	H	0.002	0.000	0.000	0.003	0.006	0.114	0.002	0.004	0.028	0.003	0.006	0.114			
	VH	0.011	0.000	0.000	0.003	0.004	0.087	0.004	0.008	0.056	0.003	0.004	0.087			
law	L	0.003*	0.000*	0.000*	0.004	0.012	0.084	0.001	0.002	0.003	0.014	0.000	0.000	0.000	0.000	0.005
	M	0.003*	0.000*	0.000*	0.005	0.016	0.110	0.004	0.004	0.005	0.026	0.002	0.013	0.027	0.001	0.015
	H	0.003*	0.000*	0.000*	0.004	0.013	0.089	0.003	0.005	0.007	0.036	0.004	0.030	0.060	0.001	0.014
	VH	0.003*	0.000*	0.000*	0.003	0.010	0.068	0.015	0.011	0.015	0.072	0.006	0.042	0.081	0.003	0.059

* empirical averages used because of "NO FIT"

It has been argued that the fitted models are superior to models that are constant over zone and month. But the absolute acceptability of these descriptive models is under question. The point is illustrated in Figures 1 and 2, which are plots of residuals vs. index number, the latter running from 1 to 396. The first 132 values are the time ordered months beginning October, 1981 and extending to September, 1992 (i.e. fiscal '82 to '92) and contain the i&b zone residuals. The second 132 values are for the same months but with the 1pass zone; similarly the last 132 values are for the 2pass zone.

Two cases were selected to illustrate the general points. The first, captains in the cbt group, exhibit residuals that are reasonably shapeless but we see a funnel structure as the zone becomes higher. The number of residuals outside of the (-2,2) interval increases. This suggests either many cells of low probability or that other sources of variability may be present, but as yet unidentified. The second case, majors in the fwp group, shows some structure. The i&b and 1pass zones seem to have two main clusters of residuals, one of which is larger in cell count and more orderly. Again we know not what is causing this. We can only say that the models presented are not yet fully descriptive.

4. Exploratory Computations

The forecasting of attritions for periods that are multiples of a single month is a follow-on problem. Associated with this problem is the consistency of twelve month rates based upon monthly data and the annual rate estimation methodology mentioned earlier.

The attrition rate methods described thus far treat the cell attritions as binomial random variables with known sample sizes. The logistic regression software treats these binomial random variables as if they were independent. The presumption of independence is easily challenged on several grounds:

FIGURE 1
Standardized Deviance Residuals

Captains: Ground Combat
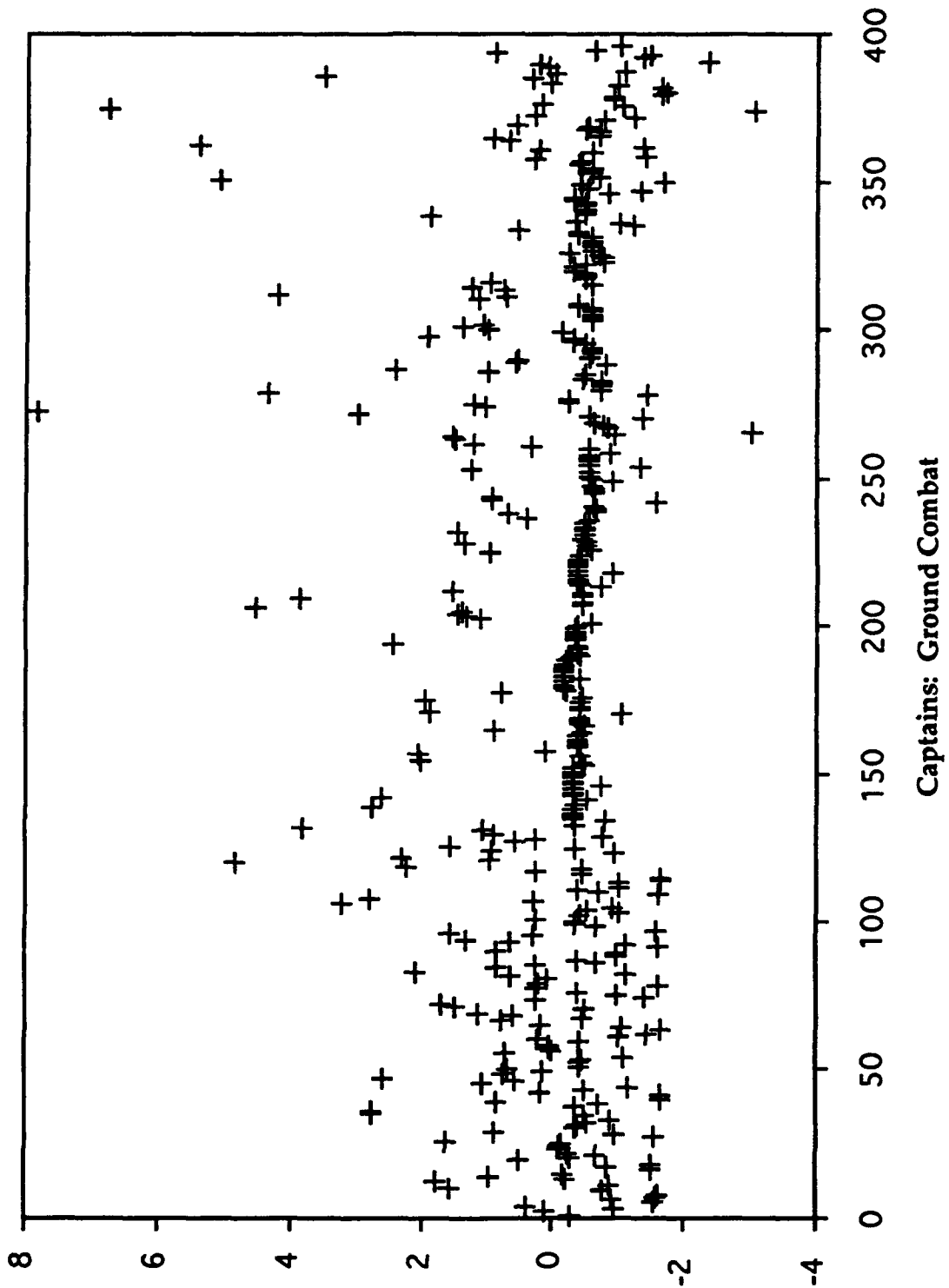
FIGURE 2
Standardized Deviance Residuals

Majors: Fixed Wing Pilots
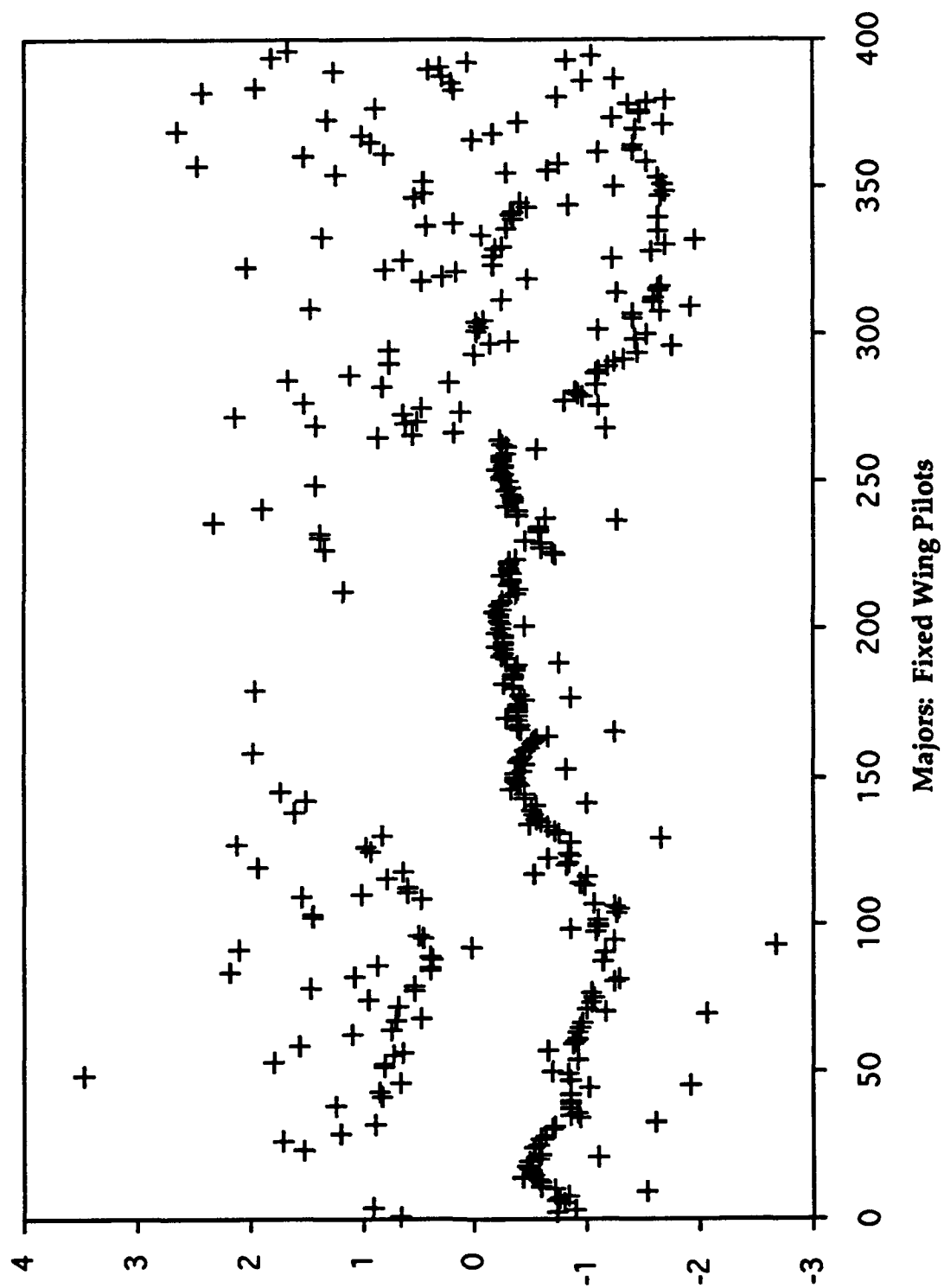
i. An officer that stays in the same cell for consecutive time periods is unlikely to be properly described as making his voluntary attrition decisions independently from month to month.

ii. The attrition behavior of an officer is surely dependent upon changes in his zone, MOS and grade.

Let us first take a brief look at the consistency issue, i.e. the comparison of annual rates produced earlier, call them Q^*, and the appropriate twelve month set $\{q_1, q_2, ..., q_{12}\}$ generated by the present techniques. It seems that there are two elementary ad hoc approaches:

i. Treat the twelve time cells as if they were populated entirely by the remnants of the personnel that were originally present the first month; no inflows or losses other than attritions. Then the $q_1, q_2, ..., q_{12}$ can be viewed as multinomial probabilities. The requisite reconciliation can be effected by solving for the constant c in the equation

$$Q^* = c \sum_1^{12} q_j \tag{4}$$

Since the Q^* are shrinkage estimates and should have the better mean squared error, we make the adjustment

$$q_j \leftarrow c q_j$$

ii. Treat the twelve months as if they were statistically independent. That is the month to month survivorships are independent. Reconcile the discrepancies by solving for c in the equation

$$1 - Q^* = c^{12} \prod_1^{12} \left(1 - q_j\right) \tag{5}$$

and make the replacement

$$q_j \leftarrow 1 - c(1 - q_j).$$

Our rates are rather small and there is not much numerical difference between the two. However, there are some cases in which the latter performs poorly. Let us use the former and provide an example of the intended use. Two annual shrinkage estimates were selected from Ref [5], specifically captains with 6 ycs in the MOS codes 7522 and 7576. The annual attrition rates are estimated to be 0.107 and 0.295, respectively. These cells belong to the fixed wing pilot group in our monthly system. The multimonial interpretation of our monthly rates would have us using an annual attrition rate of 0.090 for each. Instead we rescale the monthly rates so that they sum to the respective annual totals.

The two values of the constant c from equation (4) are

$$c = 1.1848 \quad \text{and} \quad c = 3.2664, \quad \text{respectively.}$$

These adjustments are applied to our monthly fitted rates, zone 1&b, for the twelve months in FY92, i.e. months 121, ..., 132 inclusive. The adjusted rates are

7522	0.010	0.010	0.010	0.010	0.010	0.009
	0.009	0.007	0.007	0.007	0.009	0.008
7576	0.028	0.028	0.029	0.028	0.027	0.026
	0.025	0.020	0.019	0.020	0.024	0.022

This type of rescaling is the best that we can suggest at this point.

The question of rates for time periods which are multiples of one month can be managed by accumulating the multinomial probabilities. Thus the attrition rate for months i through j could be represented by

$$qq_{ij} = \sum_{k=i}^{j} q_k. \tag{6}$$

Their empirical counterparts are commonly estimated by

$$\hat{qq}_{ij} = \left(\sum_{k=i}^{j} y_k \right) \Big/ \operatorname*{ave}_{i \le k \le j} (n_k)$$

$$\text{or} \quad \left(\sum_{k=i}^{j} y_k \right) \Big/ \operatorname*{max}_{i \le k \le j} (n_k).$$

(7)

The latter choice of these two appears to be a bit more stable. However, both forms suffer in that they are not necessarily monotone increasing functions of j. This effect is rather pronounced when the data are sparse.

Some comparisons are contained in Figures 3 and 4. In each case $i = 1$ and $j = 1, \ldots, 18$. The solid line is the result of equation (6) and the inputs are the fitted values for the indicated 18 months, i.e. they include the unemployment rate adjustment. In the comparison plots the dotted line represents the "ave" version of equation (7) and the dash-dot line is associated with the "max" version. Clearly the two empirical traces are similar and the fitted curve serves to smooth them.

Survival analysis techniques are often used to model attrition rates for enlisted personnel. In such applications the cohorts are larger and much more stable. In the case of officers there is considerable censoring. The occupants of a cell change for reasons other than attrition, i.e. promotion, failure to promote, and change of MOS. These flows can be large. The modelling process is much more difficult.

In the large we are concerned with the importance of cell to cell dependencies along the time scale. The survivor analysis approach may be useful in spite of the censoring. But this is a problem for another time.

FIGURE 3
Cumulative Attrition Rates

Colonels cbt i&b
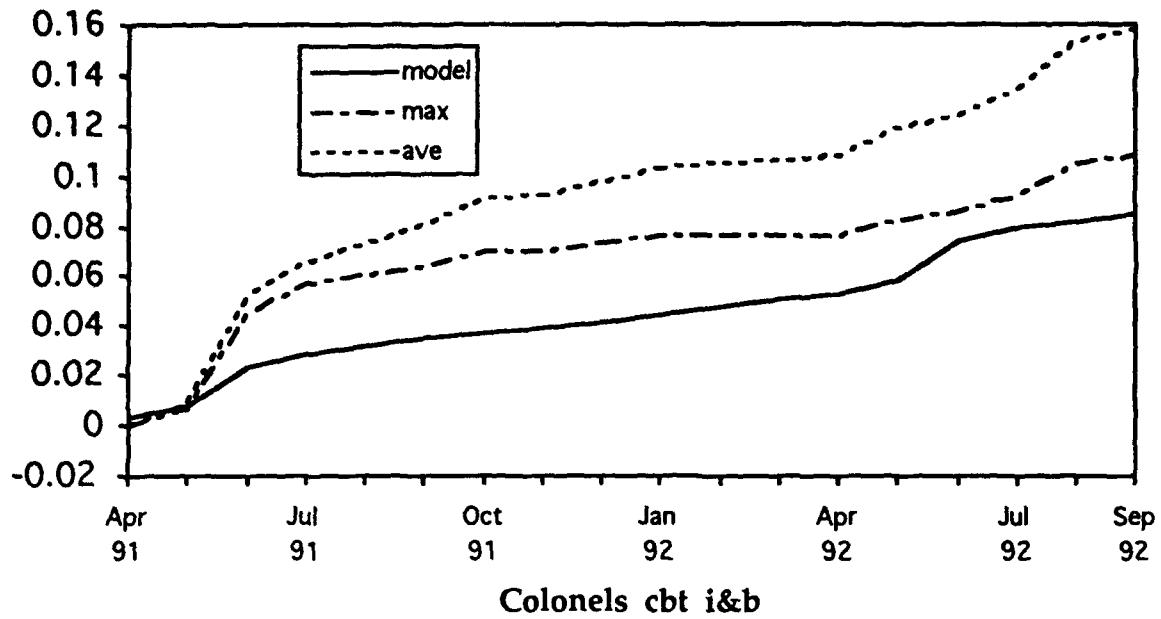
FIGURE 4
Cumulative Attrition Rates

Majors rwp 1pass

19
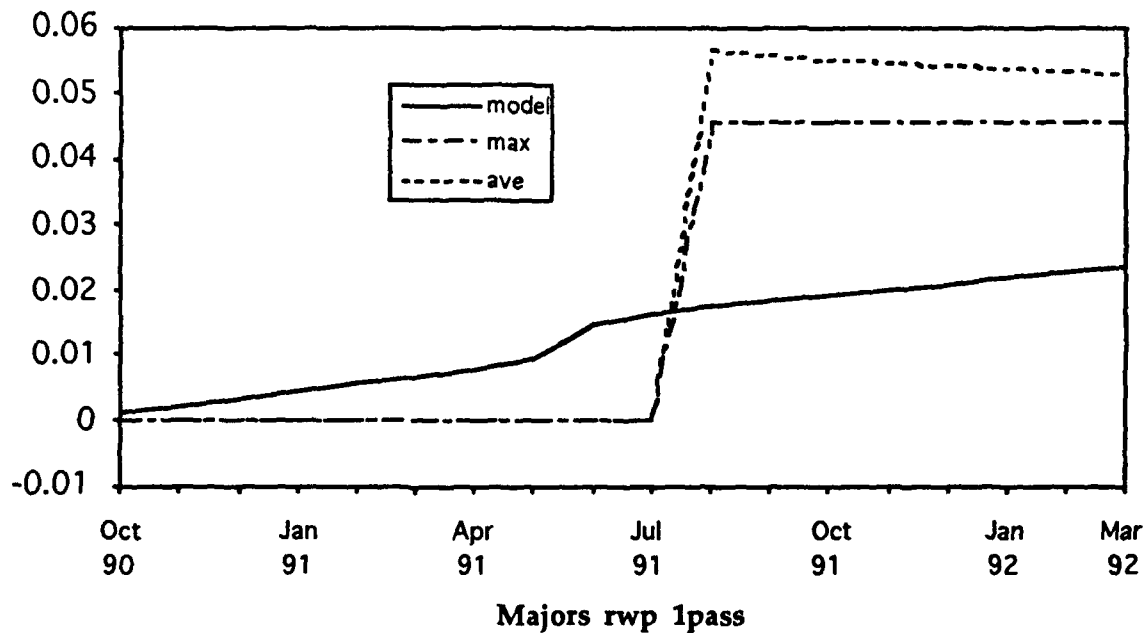
5. Conclusions

Monthly attrition rates have been modelled using logistic regression techniques. Grade, MOS, zone and season have emerged as important variables in the descriptive models. Gender has not. The use of ycs has the effect of fragmenting the data rather severely and was not used. Zone may be viewed as a coarse surrogate for ycs. We have modelled separately for the grade-MOS pairs and tried to find relationships between zone and season. The result is a system that is better than the use of constants but does not fully describe the behavior in all cases. The attrition rates themselves are rather small and it may be that sharper models are not needed. Also, it is believed that there are important covariates affecting the data. One, the unemployment rate lagged by three months was identified.

One can use the rates in Table 3 for purposes of predicting attrition for a future month. If one also has the unemployment rate for three months prior to that month, the Table 3 value can be modified by multiplying it by exp[beta(x–7.076515)] where beta is the regression coefficient for the particular grade-MOS cell from Appendix B, and x is the indicated rate.

The efficacy of our models decreases with the progression into the higher zones, largely because of the paucity of data. The consistency of our models when used for extension into time intervals of several months has been considered briefly. This problem requires further study. It is likely that some additional modelling and modification of the present system would be beneficial.

References

[1] Decision Systems Associates, Inc. (1991), "Officer Rate Generator User's Manual", Version 1.0, prepared for code MI, HQUSMC.

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[5] Read, R. R. (1992), "Performance Review of the Officer Rate Generator, Version 1.0", Naval Postgraduate School Technical Report, NPS-OR-93-002.

[6] Smyth, Gordon. (1994), personal communication.

Lt.cbt	df	Sum Sq	M Sq	F	p
unemp3	1	0.51	0.51	0.41	0.52
zone	2	554.77	277.38	223.09	0.00
month	3	13.26	4.42	3.56	0.01
Residuals	328	407.82	1.24		

Capt.cbt	df	Sum Sq	M Sq	F	p
unemp3	1	8.03	8.03	4.73	0.03
zone	2	1480.93	740.47	436.52	0.00
month	3	48.62	16.21	9.55	0.00
zone:month	6	63.94	10.66	6.28	0.00

Maj.cbt	df	Sum Sq	M Sq	F	p
unemp3	1	17.07	17.07	11.46	0.00
zone	2	444.75	222.37	149.27	0.00
month	3	120.29	40.10	26.92	0.00
Residuals	389	579.52	1.49		

Ltcol.cbt	df	Sum Sq	M Sq	F	p
unemp3	1	0.50	0.50	0.39	0.53
zone	2	408.03	204.02	157.35	0.00
month	3	56.22	18.74	14.45	0.00
Residuals	383	496.60	1.30		

Col.cbt	df	Sum Sq	M Sq	F	p
unemp3	1	8.05	8.05	4.20	0.04
zone	2	505.11	252.56	131.73	0.00
month	3	338.89	112.96	58.92	0.00
Residuals	375	718.96	1.92		

Lt.cs	df	Sum Sq	M Sq	F	p
unemp3	1	3.66	3.66	2.70	0.10
zone	2	905.36	52.68	333.94	0.00
month	3	26.85	8.95	6.60	0.00
Residuals	382	517.83	1.36		

Capt.cs	df	Sum Sq	M Sq	F	p
unemp3	1	28.96	28.96	12.91	0.0
zone	2	2212.97	106.48	493.22	0.0
month	3	52.54	17.51	7.81	0.0
zone:month	6	81.52	13.59	6.06	0.0
Residuals	377	845.75	2.24		

Maj.cs	df	Sum Sq	M Sq	F	p
unemp3	1	0.39	0.39	0.30	0.59
zone	2	485.42	242.71	184.45	0.00
month	3	206.07	68.69	52.20	0.00
Residuals	389	511.88	1.32		

Ltcol.cs	df	Sum Sq	M Sq	F	p
unemp3	1	0.96	0.96	0.71	0.40
zone	2	366.67	183.33	135.47	0.00
month	3	44.64	14.88	10.99	0.00
Residuals	383	518.33	1.35		
Lt.css	**df**	**Sum Sq**	**M Sq**	**F**	**p**
unemp3	1	3.27	3.27	1.95	0.16
zone	2	512.67	256.33	152.49	0.00
month	3	65.88	21.96	13.06	0.00
Residuals	361	606.85	1.68		
Capt.css	**df**	**Sum Sq**	**M Sq**	**F**	**p**
unemp3	1	7.42	7.42	3.25	0.07
zone	2	1705.91	52.96	373.48	0.00
month	3	73.59	24.53	10.74	0.00
zone:month	6	103.73	7.29	7.57	0.00
Residuals	383	874.71	2.28		
Maj.css	**df**	**Sum Sq**	**M Sq**	**F**	**p**
unemp3	1	0.51	0.51	0.34	0.56
zone	2	81.65	40.83	26.97	0.00
month	3	6.29	2.10	1.39	0.25
Residuals	389	588.80	1.51		
Ltcol.css	**df**	**Sum Sq**	**M Sq**	**F**	**p**
unemp3	1	1.76	1.76	1.31	0.25
zone	2	270.15	135.07	100.31	0.00
month	3	71.09	23.70	17.60	0.00
Residuals	383	515.71	1.35		
Lt.fwp	**df**	**Sum Sq**	**M Sq**	**F**	**p**
unemp3	1	17.23	17.23	20.61	0.00
zone	2	69.59	34.80	41.62	0.00
month	3	0.44	0.15	0.17	0.91
Residuals	228	190.64	0.84		
Capt.fwp	**df**	**Sum Sq**	**M Sq**	**F**	**p**
unemp3	1	43.42	43.42	32.80	0.00
zone	2	310.24	155.12	117.19	0.00
month	3	5.24	1.75	1.32	0.27
Residuals	340	450.04	1.32		
Maj.fwp	**df**	**Sum Sq**	**M Sq**	**F**	**p**
unemp3	1	29.43	29.43	25.19	0.00
zone	2	306.69	153.34	131.24	0.00
month	3	128.01	42.67	36.52	0.00
Residuals	389	454.53	1.17		
Ltcol.fwp	**df**	**Sum Sq**	**M Sq**	**F**	**p**
unemp3	1	29.67	29.67	24.80	0.00
zone	2	336.87	168.43	140.76	0.00
month	3	10.42	3.47	2.90	0.03
Residuals	383	458.29	1.20		

Lt.rwp	df	Sum Sq	M Sq	F	p
unemp3					
zone		———	NO FIT	———	
month					
Residuals					

Capt.rwp	df	Sum Sq	M Sq	F	p
unemp3	1	12.44	12.44	6.86	0.01
zone	2	935.10	467.55	257.72	0.00
mon4	3	24.08	8.03	4.42	0.00
zone:mon4	6	64.68	10.78	5.94	0.00
Residuals	375	680.33	1.81		

Maj.rwp	df	Sum Sq	M Sq	F	p
unemp3	1	9.25	9.25	6.62	0.01
zone	2	374.16	187.08	133.99	0.00
mon4	3	135.31	45.10	32.30	0.00
Residuals	389	543.13	1.40		

Ltcol.rwp	df	Sum Sq	M Sq	F	p
unemp3	1	0.05	0.05	0.04	0.84
zone	2	263.14	131.57	113.80	0.00
mon4	3	19.72	6.57	5.68	0.00
Residuals	383	442.81	1.16		

Lt.ags	df	Sum Sq	M Sq	F	p
unemp3	1	0.47	0.47	0.45	0.50
zone	2	214.91	107.45	102.57	0.00
mon4	3	43.87	14.62	13.96	0.00
Residuals	299	313.24	1.05		

Capt.ags	df	Sum Sq	M Sq	F	p
unemp3	1	5.10	5.10	4.12	0.04
zone	2	308.97	154.48	124.64	0.00
mon4	3	1.40	0.47	0.38	0.77
Residuals	347	430.09	1.24		

Maj.ags	df	Sum Sq	M Sq	F	p
unemp3	1	2.19	2.19	1.97	0.16
zone	2	107.33	53.67	48.27	0.00
mon4	3	28.51	9.50	8.55	0.00
Residuals	389	432.50	1.11		

Ltcol.ags	df	Sum Sq	M Sq	F	p
unemp3	1	1.63	1.63	1.66	0.20
zone	2	73.29	36.64	37.32	0.00
mon4	3	5.14	1.71	1.75	0.16
Residuals	371	364.32	0.98		

Lt.nfo	df	Sum Sq	M Sq	F	p
unemp3	1	6.81	6.81	4.02	0.05
zone	2	0.07	0.04	0.02	0.98
mon4	3	21.36	7.12	4.21	0.01
Residuals	167	282.77	1.69		

Capt.nfo	df	Sum Sq	M Sq	F	p
unemp3	1	5.10	5.10	3.81	0.05
zone	2	356.33	178.16	133.30	0.00
mon4	3	6.02	2.01	1.50	0.21
Residuals	352	470.47	1.34		
Maj.nfo	df	Sum Sq	M Sq	F	p
unemp3	1	7.46	7.46	6.08	0.01
zone	2	162.69	81.35	66.30	0.00
mon4	3	31.88	10.63	8.66	0.00
Residuals	389	477.29	1.23		
Ltcol.nfo	df	Sum Sq	M Sq	F	p
unemp3	1	5.10	5.10	3.81	0.05
zone	2	356.33	178.16	133.30	0.00
mon4	3	6.02	2.01	1.50	0.21
Residuals	352	470.47	1.34		
Lt.law	df	Sum Sq	M Sq	F	p
unemp3					
zone		——	NO FIT	——	
month					
Residuals					
Capt.law	df	Sum Sq	M Sq	F	p
unemp3	1	0.01	0.01	0.01	0.92
zone	2	113.37	56.69	50.10	0.00
mon4	3	2.36	0.79	0.69	0.56
Residuals	286	323.59	1.13		
Maj.law	df	Sum Sq	M Sq	F	p
unemp3	1	12.41	12.41	7.27	0.01
zone	2	40.23	20.12	11.79	0.00
mon4	3	39.03	13.01	7.62	0.00
Residuals	383	653.58	1.71		
Ltcol.law	df	Sum Sq	M Sq	F	p
unemp3	1	5.93	5.93	4.82	0.03
zone	2	51.91	25.96	21.08	0.00
mon4	3	11.08	3.69	3.00	0.03
Residuals	348	428.40	1.23		
Col.law	df	Sum Sq	M Sq	F	p
unemp3	1	1.32	1.32	1.73	0.19
zone	2	29.61	14.81	19.38	0.00
mon4	3	7.35	2.45	3.20	0.02
Residuals	371	283.48	0.76		

APPENDIX B
Parameter Estimates

Lt.cbt	Value	s.d.	t
const	-3.88	0.33	-11.90
unemp3	-0.02	0.04	-0.48
1pass	0.94	0.12	7.98
2pass	1.01	0.06	15.58
L	-0.63	0.19	-3.33
M	0.10	0.07	1.40
VH	0.11	0.06	1.76
Capt.cbt	**Value**	**s.d.**	**t**
const	-3.86	0.23	-16.99
unemp3	-0.03	0.03	-0.81
1pass	0.74	0.10	7.37
2pass	0.88	0.05	16.74
L	0.59	0.11	5.32
M	-0.12	0.05	-2.50
VH	-0.01	0.05	-0.21
1pass:L	0.49	0.15	3.30
2pass:L	0.28	0.07	4.00
1pass:M	-0.18	0.06	-2.81
2pass:M	0.03	0.03	0.99
1pass:VH	0.00	0.07	-0.07
2pass:VH	-0.11	0.04	-2.75
Maj.cbt	**Value**	**s.d.**	**t**
const	-4.36	0.36	-12.22
unemp3	-0.19	0.05	-3.98
1pass	0.24	0.19	1.27
2pass	0.98	0.07	14.53
L	-0.41	0.17	-2.35
M	-0.03	0.07	-0.40
VH	0.40	0.04	9.22
Ltcol.cbt	**Value**	**s.d.**	**t**
const	-4.36	0.27	-16.38
unemp3	0.02	0.04	0.46
1pass	0.79	0.08	10.14
2pass	0.49	0.04	13.14
L	-0.35	0.14	-2.49
M	0.02	0.05	0.45
VH	0.26	0.04	6.70
Col.cbt	**Value**	**s.d.**	**t**
const	-4.20	0.20	-20.51
unemp3	0.00	0.03	-0.02
1pass	0.74	0.06	11.46
2pass	0.53	0.03	19.06
L	-0.68	0.13	-5.10
M	0.04	0.05	0.87
H	0.44	0.03	14.97

Lt.cs	Value	s.d.	t
Intercept	-3.38	0.26	-13.06
unemp3	-0.05	0.04	-1.44
1pass	1.04	0.08	13.17
2pass	0.91	0.05	19.44
L	-0.40	0.12	-3.39
M	-0.04	0.05	-0.81
H	0.10	0.04	2.34
Capt.cs	**Value**	**s.d.**	**t**
(Intercept)	-3.66	0.21	-17.35
unemp3	-0.08	0.03	-2.70
1pass	0.43	0.12	3.56
2pass	1.05	0.05	20.04
L	0.54	0.13	4.33
M	-0.07	0.05	-1.44
H	-0.01	0.06	-0.20
1pass:L	0.60	0.18	3.38
2pass:L	0.29	0.07	3.98
1pass:M	-0.11	0.07	-1.49
2pass:M	0.01	0.03	0.49
1pass:VH	-0.02	0.08	-0.29
2pass:VH	-0.07	0.04	-1.94
Maj.cs	**Value**	**s.d.**	**t**
(Intercept)	-4.94	0.30	-16.19
unemp3	-0.07	0.04	-1.76
1pass	0.47	0.14	3.28
2pass	0.87	0.05	16.34
L	-0.44	0.17	-2.53
M	0.03	0.06	0.47
H	0.47	0.04	11.97
Ltcol.cs	**Value**	**s.d.**	**t**
(Intercept)	-3.89	0.30	-12.94
unemp3	-0.04	0.04	-0.99
1pass	0.87	0.08	10.39
2pass	0.50	0.04	12.27
L	-0.39	0.16	-2.43
M	0.05	0.06	0.79
H	0.26	0.04	6.06
Lt.css	**Value**	**s.d.**	**t**
(Intercept)	-3.82	0.26	-14.92
unemp3	0.00	0.04	0.11
1pass	0.83	0.09	9.50
2pass	0.81	0.05	14.72
L	-0.59	0.13	-4.52
M	-0.08	0.05	-1.55
H	0.14	0.04	3.49

Capt.css	Value	s.d.	t
(Intercept)	-3.66	0.21	-17.35
unemp3	-0.08	0.03	-2.70
1pass	0.43	0.12	3.56
2pass	1.05	0.05	20.04
L	0.54	0.13	4.33
M	-0.07	0.05	-1.44
H	-0.01	0.06	-0.20
1pass:L	0.60	0.18	3.38
2pass:L	0.29	0.07	3.98
1pass:M	-0.11	0.07	-1.49
2pass:M	0.01	0.03	0.49
1pass:VH	-0.02	0.08	-0.29
2pass:VH	-0.07	0.04	-1.94

Maj.css	Value	s.d.	t
(Intercept)	-5.02	0.42	-11.95
unemp3	-0.10	0.06	-1.65
1pass	0.64	0.11	5.66
2pass	0.29	0.06	4.77
L	-0.34	0.21	-1.62
M	0.09	0.08	1.20
H	0.15	0.07	2.32

Ltcol.css	Value	s.d.	t
(Intercept)	-4.20	0.31	-13.74
unemp3	0.03	0.04	0.80
1pass	0.84	0.08	10.24
2pass	0.40	0.04	9.14
L	-0.53	0.17	-3.10
M	0.01	0.06	0.19
H	0.30	0.04	7.05

Lt.fwp	Value	s.d.	t
(Intercept)	-6.06	4.62	-1.31
unemp3	-0.02	0.17	-0.11
1pass	1.21	0.54	2.24
2pass	1.44	0.25	5.77
L	-3.35	8.83	-0.38
M	1.25	2.95	0.43
H	0.63	1.50	0.42

Capt.fwp	Value	s.d.	t
(Intercept)	-1.77	0.26	-6.83
unemp3	-0.26	0.04	-7.14
1pass	0.56	0.10	5.49
2pass	0.79	0.06	12.18
L	0.10	0.09	1.07
M	0.04	0.04	1.08
H	-0.06	0.05	-1.23

Maj.fwp	Value	s.d.	t
(Intercept)	-2.94	0.35	-8.42
unemp3	-0.33	0.05	-6.83
1pass	0.22	0.15	1.45
2pass	0.74	0.06	13.12
L	-0.41	0.18	-2.32
M	0.04	0.07	0.57
H	0.41	0.04	9.80
Ltcol.fwp	**Value**	**s.d.**	**t**
(Intercept)	-2.78	0.29	-9.67
unemp3	-0.16	0.04	-3.86
1pass	0.98	0.07	14.30
2pass	0.35	0.04	8.28
L	-0.46	0.15	-3.00
M	0.10	0.06	1.78
H	0.10	0.05	2.08
Lt.rwp	**Value**	**s.d.**	**t**
——	NO FIT	——	
Capt.rwp	**Value**	**s.d.**	**t**
(Intercept)	-3.51	0.24	-14.55
unemp3	-0.08	0.03	-2.35
1pass	0.65	0.13	5.14
2pass	0.86	0.07	12.73
L	0.45	0.15	3.06
M	-0.03	0.06	-0.57
H	-0.02	0.07	-0.28
1pass:L	0.19	0.19	0.99
2pass:L	0.52	0.10	5.27
1pass:M	-0.05	0.08	-0.69
2pass:M	-0.02	0.04	-0.61
1pass:VH	0.07	0.08	0.80
2pass:VH	-0.02	0.05	-0.35
Maj.rwp	**Value**	**s.d.**	**t**
(Intercept)	-4.47	0.37	-12.14
unemp3	-0.18	0.05	-3.54
1pass	0.18	0.20	0.89
2pass	0.96	0.07	13.56
L	-0.33	0.18	-1.87
M	-0.03	0.07	-0.50
H	0.42	0.04	9.80
Ltcol.rwp	**Value**	**s.d.**	**t**
(Intercept)	-4.22	0.33	-12.76
unemp3	0.01	0.05	0.18
1pass	0.64	0.10	6.43
2pass	0.53	0.05	10.81
L	-0.41	0.17	-2.35
M	0.03	0.06	0.53
H	0.19	0.05	3.77

Lt.ags	Value	s.d.	t
(Intercept)	-3.53	0.49	-7.24
unemp3	-0.01	0.07	-0.10
1pass	0.87	0.16	5.34
2pass	0.95	0.10	9.94
L	-0.30	0.16	-1.84
M	-0.36	0.07	-4.92
H	-0.10	0.09	-1.10
Capt.ags	**Value**	**s.d.**	**t**
(Intercept)	-3.37	0.43	-7.78
unemp3	-0.09	0.06	-1.51
1pass	0.62	0.16	3.94
2pass	0.90	0.08	11.78
L	0.12	0.15	0.80
M	-0.04	0.06	-0.72
H	0.03	0.07	0.44
Maj.ags	**Value**	**s.d.**	**t**
(Intercept)	-5.21	0.62	8.42
unemp3	0.00	0.08	0.00
1pass	0.54	0.23	2.35
2pass	0.70	0.09	7.56
L	-0.90	0.52	1.73
M	0.23	0.18	1.25
H	0.46	0.10	4.37
Ltcol.ags	**Value**	**s.d.**	**t**
(Intercept)	-5.00	0.63	7.88
unemp3	0.12	0.08	1.50
1pass	0.82	0.19	4.23
2pass	0.50	0.09	5.29
L	-0.51	0.38	1.35
M	0.07	0.14	0.52
H	0.20	0.10	1.95
Lt.law	**Value**	**s.d.**	**t**
——	NO FIT	——	
Capt.law	**Value**	**s.d.**	**t**
(Intercept)	-3.09	0.56	5.56
unemp3	-0.14	0.07	1.93
1pass	0.62	0.21	2.91
2pass	0.87	0.12	7.36
L	-0.04	0.23	0.16
M	0.09	0.08	1.03
H	-0.09	0.11	0.80

Maj.law	Value	s.d.	t
(Intercept)	-4.09	0.70	5.85
unemp3	-0.21	0.09	2.42
1pass	-0.78	0.50	1.56
2pass	0.73	0.18	4.08
L	-0.49	0.39	1.28
M	0.19	0.14	1.42
H	0.46	0.08	5.46
Ltcol.law	Value	s.d.	t
(Intercept)	-3.08	0.78	3.94
unemp3	-0.22	0.11	1.94
1pass	0.17	0.30	0.56
2pass	0.60	0.12	4.83
L	-0.50	0.38	1.30
M	0.06	0.14	0.42
H	0.29	0.10	2.96
Col.law	Value	s.d.	t
(Intercept)	-4.96	3.58	1.38
unemp3	-0.14	0.14	1.00
1pass	1.02	0.29	3.46
2pass	0.58	0.13	4.54
L	-3.83	6.92	0.55
M	1.00	2.31	0.43
H	0.79	1.16	0.68

APPENDIX C
Eleven Year Averages

Females/Grnd		Lt	Capt	Maj	Ltcol	Col	total
i&b	inv	125	172	59	23	6	385
	loss	7	14	1	1	1	24
1pass	inv	2	5	5	2	1	14
	loss	1	1	0	1	0	2
2pass	inv	1	4	9	2	1	17
	loss	1	3	2	1	0	8
Males/Grnd		**Lt**	**Capt**	**Maj**	**Ltcol**	**Col**	**total**
i&b	inv	1853	2886	1469	812	270	7290
	loss	76	130	24	40	13	284
1pass	inv	37	99	137	63	55	391
	loss	10	11	5	15	11	52
2pass	inv	*12	*49	210	86	79	436
	loss	19	67	58	40	40	223
Males/Aviation		**Lt**	**Capt**	**Maj**	**Ltcol**	**Col**	**total**
i&b	inv	628	1352	775	483	132	3370
	loss	8	89	13	30	8	148
1pass	inv	3	32	95	33	25	189
	loss	0	6	2	12	6	26
2pass	inv	1	*14	153	36	33	237
	loss	1	19	39	19	18	95

* Losses exceed inventories because these are averages. They were set equal (to the losses) in order to allow the programs to function.

APPENDIX D
Unemployment Rate - by fiscal year

	81	82	83	84	85	86	87	88	89	90	91	92
Oct	7.6	8.0	10.5	8.8	7.4	7.1	6.9	6.0	5.3	5.3	5.7	6.8
Nov	7.5	8.3	10.7	8.4	7.2	7.0	6.9	5.9	5.4	5.3	5.9	6.9
Dec	7.4	8.8	10.8	8.2	7.4	6.9	6.7	5.8	5.3	5.3	6.1	7.1
Jan	7.4	8.5	10.4	8.0	7.4	6.7	6.7	5.8	5.4	5.3	6.2	7.3
Feb	7.3	8.8	10.4	7.8	7.3	7.3	6.7	5.7	5.1	5.3	6.5	7.3
Mar	7.3	9.0	10.3	7.8	7.3	7.2	6.7	5.6	5.0	5.2	6.8	7.2
Apr	7.3	9.4	10.2	7.8	7.3	7.1	6.3	5.5	5.3	5.4	6.6	7.2
May	7.6	9.5	10.1	7.5	7.3	7.2	6.3	5.6	5.2	5.3	6.9	7.4
Jun	7.3	9.5	10.0	7.1	7.3	7.1	6.1	5.4	5.3	5.2	7.0	7.8
Jul	7.0	9.8	9.5	7.5	7.3	7.0	6.0	5.4	5.3	5.5	6.8	7.6
Aug	7.2	9.9	9.5	7.5	7.1	6.8	6.0	5.6	5.3	5.6	6.8	7.6
Sep	7.5	10.2	9.2	7.4	7.1	7.0	5.9	5.4	5.3	5.7	6.7	7.5

Source: Monthly Labor Review

Promotion Board Convening Dates

	Colonel	Ltcol	Major	Captain
FY82	18Feb81	24Feb81	16Jun81	22Jun81
FY83	9Feb82	19Feb82	7Apr82	21Apr82
FY84	9Feb83	15Feb83	8Mar83	19Apr83
FY85	7Feb84	22Feb84	13Mar84	1May84
FY86	5Feb85	20Feb85	12Mar85	30Apr85
FY87	11Feb86	25Feb86	18Mar86	30Apr86
FY88	13Jan87	28Jan87	25Feb87	15Apr87
FY89	26Jan88	9Feb88	22Mar88	16May88
FY90	24Jan89	14Feb89	14Mar89	10May89
FY91	17Jan90	13Feb90	13Mar90	14Apr90
FY92	14Nov90	15Jan91	12Feb91	10Apr91
FY93	13Nov91	14Jan92	11Feb92	31Mar92
FY94	13Nov92	12Jan93	9Feb93	9Mar93

Source: Code MI: HQUSMC

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